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PRL-TDR-63-15

# An Application to Job Evaluation of a Policy-Capturing Model for Analyzing Individual and Group Judgment

By

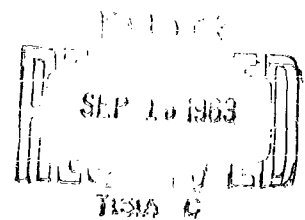
Joseph M. Madden, Maj USAF

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Technical Documentary Report PRL-TDR-63-15

May 1963

6570TH PERSONNEL RESEARCH LABORATORY  
AEROSPACE MEDICAL DIVISION  
AIR FORCE SYSTEMS COMMAND  
Lackland Air Force Base, Texas



Project 7734, Task 773402

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<p>6570th Personnel Research Laboratory, Aerospace Medical Division, Lackland AF Base, Tex.          Rep No. PRL-TDR-63-15. AN APPLICATION TO JOB EVALUATION OF A POLICY-CAPTURING MODEL FOR ANALYZING INDIVIDUAL AND GROUP JUDGMENT. May 63, iii + 5 p.      Unclassified Report</p> <p>A major problem in developing a job evaluation plan is the estimation of individual rater consistency and degree of interrater agreement. A method for making these estimations is proposed which combines a multiple regression model with a mathematical grouping model in quantifying a measure of predictive efficiency. Officers ranked 50 simulated Air Force specialties, each of which consisted of pre-assigned scale values for 10 job requirement factors. 38 officers ranked the jobs on the basis of merited grade, 30 on merited pay. Each rater's</p>	<ol style="list-style-type: none"> <li>1 Job analysis</li> <li>2 Office personnel</li> <li>3 Psychometrics</li> <li>4 Military requirements</li> <li>5 Simulation</li> <li>6 Statistical analysis</li> <li>7 Reliability</li> <li>8 Standards</li> <li>9 Data</li> <li>10 Wages</li> </ol> <p>I AFSC Proj(Task) 7734(02)          II J.M. Madden, Maj USAF          III In ASTIA collection</p>
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#### ABSTRACT

A major problem in developing a job evaluation plan is the estimation of individual rater consistency and degree of interrater agreement. A method for making these estimations is proposed which combines a multiple regression model with a mathematical grouping model in quantifying a measure of predictive efficiency. Officers ranked 50 simulated Air Force specialties, each of which consisted of pre-assigned scale values for 10 job requirement factors. 38 officers ranked the jobs on the basis of merited grade, 36 on merited pay. Each rater's consistency was evaluated by a multiple regression equation predicting his rank-ordering of the jobs from the factor values. Consistency of policy among raters was measured by the loss in predictive efficiency when a single equation represented the joint policy of the group. Measures of rater consistency showed that all but 2 of the raters were adequately consistent. Measures of interrater agreement indicated that raters were applying a homogeneous policy, whether they ranked on merited pay or merited grade. The officer raters (captains and majors) were capable of applying a consistent policy in evaluating jobs when their only information was an estimate of the job requirements.

This report has been reviewed and is approved.

Fred E. Holdrege, Col USAF  
Commander

A. Carp  
Technical Director

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## AN APPLICATION TO JOB EVALUATION OF A POLICY-CAPTURING MODEL FOR ANALYZING INDIVIDUAL AND GROUP JUDGMENT

Ward (1961) introduced a concept of grouping or clustering in an iterative fashion which enables the investigator to specify the cost of grouping at each iteration in the procedure. The cost is expressed in terms of a function defined by the investigator. Bottenberg & Christal (1961) describe an application of this concept where the function is predictive efficiency and the objective is to minimize loss of predictive efficiency as the grouping proceeds. Christal (1963) discusses application of the predictive efficiency function to the development of on-the-job criterion composites using simulated job incumbents, to job evaluation using simulated jobs, and to identifying a homogeneous policy among selection board members. In discussing these applications, the method is referred to as JAN for judgment analysis.

In Christal's discussion of the job evaluation application, it is suggested that jobs may be simulated by use of ratings on a series of job evaluation factors. Narrative description is to be omitted and the judge is asked to make criterion decisions based on the factor ratings only. In this manner, the job is simulated and influences present in job descriptions which tend to distort judgment, such as prestige value, are eliminated.

After criterion decisions, such as a rank ordering of a set of simulated jobs, have been obtained, the first step in the analysis procedure is to compute a least squares solution of a multiple regression equation to predict the criterion decisions given by each rater, using the factor ratings as predictors. Using the  $R^2$  computed for each individual, unacceptable raters may be eliminated by comparing the  $R^2$ s computed from their equations with the  $R^2$ s obtained for the other judges in the sample. Next, a single value of  $R^2$  is computed to indicate the overall predictive efficiency when all the individual rater equations are considered. Then every individual equation is compared with all others, and the two raters who have the most homogeneous equations are located. The computer prints the single equation that best represents the joint policy of these two judges as well as the loss in overall predictive efficiency that results when the  $N$  original equations are reduced to  $N-1$  equations. Subsequently, the procedure systematically reduces the number of raters or rater clusters by one at each step until all raters have been grouped into a single cluster. At each step, examination of the loss in overall predictive efficiency (the reduction in  $R^2$ ) makes it possible to identify the different policies which may exist in the sample.

The application of JAN to the resolution of board or group disagreement described by Christal is a special case of policy analysis. If the policies of a group of judges are not homogeneous, as expressed by regression equations, the source of disagreement in terms of specific factors can be located. Arbitration then can be efficiently directed to the source of heterogeneity of policy. Furthermore, the nature of the policy structure in the group can be identified. There may be two distinct and clear-cut policies which divide the group into two parts or there may be many separate policies with widespread disagreement distributed among all the factors being used. Such a policy analysis is not only pertinent as a measure of interrater agreement but it identifies the source and extent of disagreement.

Several desirable attributes of this procedure are described in Christal's paper. One is that the rater is unable to display any halo effect since he is judging job characteristics and not the job itself. Another is that the  $R^2$  computed for each rater is an evaluation of his

Formal Education	4
Special Training and Work Experience	200
Judgment	34
Originality, Ingenuity, and Creativeness	44
Communication Skills	500
Interpersonal Skills	04
Decision Making	7
Planning	00
Management	9
Special Work Conditions	10
Rank No.	4

Fig. 1. Sample card used to simulate a job.

consistency.<sup>1</sup> Further, it is of considerable value to be able to identify the homogeneity of the policies of the judges. If very little predictive efficiency is lost by grouping, we have a strong indication that all judges in the sample tend to use essentially the same policy. In this respect, an expression of the degree of interrater agreement is provided.

#### PURPOSE

In the development of a job evaluation plan for the Air Force, one of the critical tasks is assuring that interrater agreement is high in the population which makes the judgments which form the basis of the plan. If interrater agreement is measured in terms of homogeneity of policy, the additional information concerning the policy structure in a sample will also describe the nature of the agreement or disagreement. It is also desirable to identify a method for assessing the consistency of judgment for any particular judge. The purpose of this paper is to report an application of JAN to the estimation of homogeneity of policy and individual rater reliability.

#### METHOD

A different simulated job was printed on each of 50 cards. Samples of judges then ranked all 50 cards on either merited pay or merited grade.

#### Simulation of Jobs

A sample of 50 officer job descriptions was selected from a group of 144 job descriptions which were representative of Air Force officer jobs and available from a previous study Madden, (1963a). Two psychologists experienced in job evaluation rated each of the 50 jobs on 10 factors. Differences were then arbitrated until a single value for each job on each of the 10 factors was agreed upon. For each job, the 10 factor names and the corresponding factor values were printed on a card as shown in Figure 1. The officers selected to rank-order the simulated jobs were informed that each card represented an officer job and that the ratings given on the 10 factors were typical of the ratings ordinarily assigned to the job.

<sup>1</sup>This might be untrue for the unlikely situation in which the judge has taken into account interactions among the predictors or nonlinear relationships between one or more of the predictors and the criterion which have not been included in the model.

### Ranking the 50 Simulated Jobs

Captains and majors who were students in the 61-62 class at Air Force Command and Staff College served as judges. Merited pay was the basis of ranking for 38 judges, and merited grade was the basis of ranking for 36 judges. After each judge had ranked the 50 simulated jobs, he wrote the rank number, from 1-50, in the lower right corner (labelled "RANK NR" in Figure 1) of each of the 50 cards.

### RESULTS

The policy of each rater was expressed in a regression equation predicting his rank-ordering of the jobs from the factor values. Table 1 gives the distribution of  $R^2$  for the 36 judges who ranked the simulated jobs in terms of merited grade and the 38 judges who ranked them in terms of merited pay. The  $R^2$ s of .15 and .31 showed these two judges to be so inconsistent as to disqualify them as judges. Hence they were not included in the grouping computations.

The results of the grouping procedures are summarized in Table 2 for the two groups of judges, separately and combined. As the number of groups was reduced to three  $R^2$  decreased from .93 to .88 for merited pay judgments, from .92 to .88 for merited grade, and from .93 to .86 for the combined sets. The final  $R^2$ s for one group, were .78, .84 and .81 respectively.

### DISCUSSION

That  $R^2$ s were over .70 for all except two cases indicates a high level of predictability of the rank ordering of the 50 simulated jobs from knowledge of factor scores. The officers in these samples are able to utilize the scores on 10 job evaluation factors in a consistent manner so that the rank ordering of 50 patterns of 10 scores is predictable to the high degree indicated in Table 1. It may be concluded that these

Table 1. Distribution of  $R^2$ s Predicting Rank Order From Factor Values

$R^2$	Merited Pay	Merited Grade
.99	1	
.98	2	5
.97	6	7
.96	6	2
.95	6	2
.94	3	2
.93	1	0
.92	4	3
.91	1	0
.90	3	2
.89	1	5
.88	1	1
.87	1	2
.86	1	1
.85		1
.74	1	
.72		1
.31		1
.15		1
N	38	36

Table 2. Effect on  $R^2$ s of Number of Groups

Basis of Ranking	No. of Groups	No. of Judges in Each Group	$R^2$
Merited Pay (N = 38)	38	1	.93
	3	33, 4, 1	.88
	2	37, 1	.87
	1	38	.78
Merited Grade (N = 34)	34	1	.92
	3	16, 16, 2	.88
	2	32, 2	.86
	1	34	.84
Merited Grade & Merited Pay (N = 72)	72	1	.93
	3	64, 5, 3	.86
	2	67, 5	.83
	1	72	.81

officers can make reliable judgments concerning simulated jobs, and, further, that judges who are inconsistent as evidenced by low  $R^2$ s may be identified and eliminated on the basis of their performance as judges.

Although raters may be consistent in terms of the application of their own policies, they may be in marked disagreement with other judges who are themselves consistent. If the rankings for  $N$  judges are treated as a single variable and a single  $R^2$  computed, the  $R^2$  for the  $N$  judges is a measure of the homogeneity of the  $N$  equations and indicates the amount of agreement among the  $N$  policies (Bottenberg & Christal, 1961).

Table 2 may be interpreted in terms of the agreement among policies at various stages of grouping for each of the two experimental conditions. Generally, the greatest loss occurs toward the end of the grouping procedure or, in other words, the rate of loss of predictive efficiency increases with each step. Interpretation, then, may be made in two ways: (a) the value of  $R^2$  for the final step when all cases are in a single group; and (b) the value of  $R^2$  for a particular step viewed in terms of the number of groups and the number of cases in each. For the two samples in this study, policy is more homogeneous when the basis of ranking is merited grade ( $R^2 = .84$ ) than when ranking is based on merited pay ( $R^2 = .78$ ), and intermediate ( $R^2 = .81$ ) when both samples are combined. All of these values, however, reflect an adequate level of interrater agreement. Looking at specific steps, this appearance is strengthened. In the merited pay sample, for instance, a great deal is lost on the last step when one case is added to a group of 37 cases and  $R^2$  drops from .87 to .78.

The pattern of grouping for merited grade is of special interest. At the 3-group stage there are two groups of 16 cases each and one group consisting of 2 cases. The two large groups might appear at first glance to represent two different homogeneous policies, but when these two groups are combined into a single group on the next step, the drop in  $R^2$  is only .02.

It appears from these results that policy regarding merited pay and merited grade are homogeneous among the officers in these two samples when judgments are based on simulated jobs. Previous studies (Madden, 1963a, 1963b) have indicated that jobs are ranked differently in terms of merited pay than when merited grade is the basis of ranking, and that the formula which best predicts merited pay is less predictive of merited grade and vice versa.

It might be hypothesized that the definition of rating factors tends to be supplemented by the object being rated and that when the object is simulated, this supplementary definition is not present. It seems then, that a study utilizing two conditions, one where the object itself is rated and one where it is simulated, would yield some insight into the nature of this supplementary definition which is provided by the object rated. In job evaluation, much could be learned about prestige or glamour effects.

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- Christal, R. E. *JAN: A technique for analyzing individual and group judgment*. Lackland Air Force Base, Texas: 6570th Personnel Research Laboratory, Aerospace Medical Division, February 1963. (PRL-TDR-63-3, ASTIA Document AD-403 813)

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<p>6570th Personnel Research Laboratory, Aerospace Medical Division, Lackland AF Base, Tex. Rpt No. PRL-TDR-63-15. AN APPLICATION TO JOB EVALUATION OF A POLICY-CAPTURING MODEL FOR ANALYZING INDIVIDUAL AND GROUP JUDGMENT. May 63, iii + 5 p.      Unclassified Report</p> <p>A major problem in developing a job evaluation plan is the estimation of individual rater consistency and degree of interrater agreement. A method for making these estimations is proposed which combines a multiple regression model with a mathematical grouping model in quantifying a measure of predictive efficiency. Officers ranked 50 simulated Air Force specialties, each of which consisted of pre-assigned scale values for 10 job requirement factors. 38 officers ranked the jobs on the basis of merited grade. 36 on merited pay. Each rater's</p>	<p>consistency was evaluated by a multiple regression equation predicting his rank-ordering of the jobs from the factor values. Consistency of policy among raters was measured by the loss in predictive efficiency when a single equation represented the joint policy of the group. Measures of rater consistency showed that all but 2 of the raters were adequately consistent. Measures of interrater agreement indicated that raters were applying a homogeneous policy, whether they ranked on merited pay or merited grade. The officer raters (captains and majors) were capable of applying a consistent policy in evaluating jobs when their only information was an estimate of the job requirements.</p>
<ol style="list-style-type: none"> <li>1 Job analysis</li> <li>2 Officer personnel</li> <li>3 Psychometrics</li> <li>4 Military requirements</li> <li>5 Simulation</li> <li>6 Statistical analysis</li> <li>7 Reliability</li> <li>8 Standards</li> <li>9 Data</li> <li>10 Wages</li> <li>I AFSC Proj(Task) 7734(02)</li> <li>II J.M. Madden, Maj USAF</li> <li>III In ASTIA collection</li> </ol>	

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